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EARLY EROSION-CONTROL PRACTICES IN VIRGINIA

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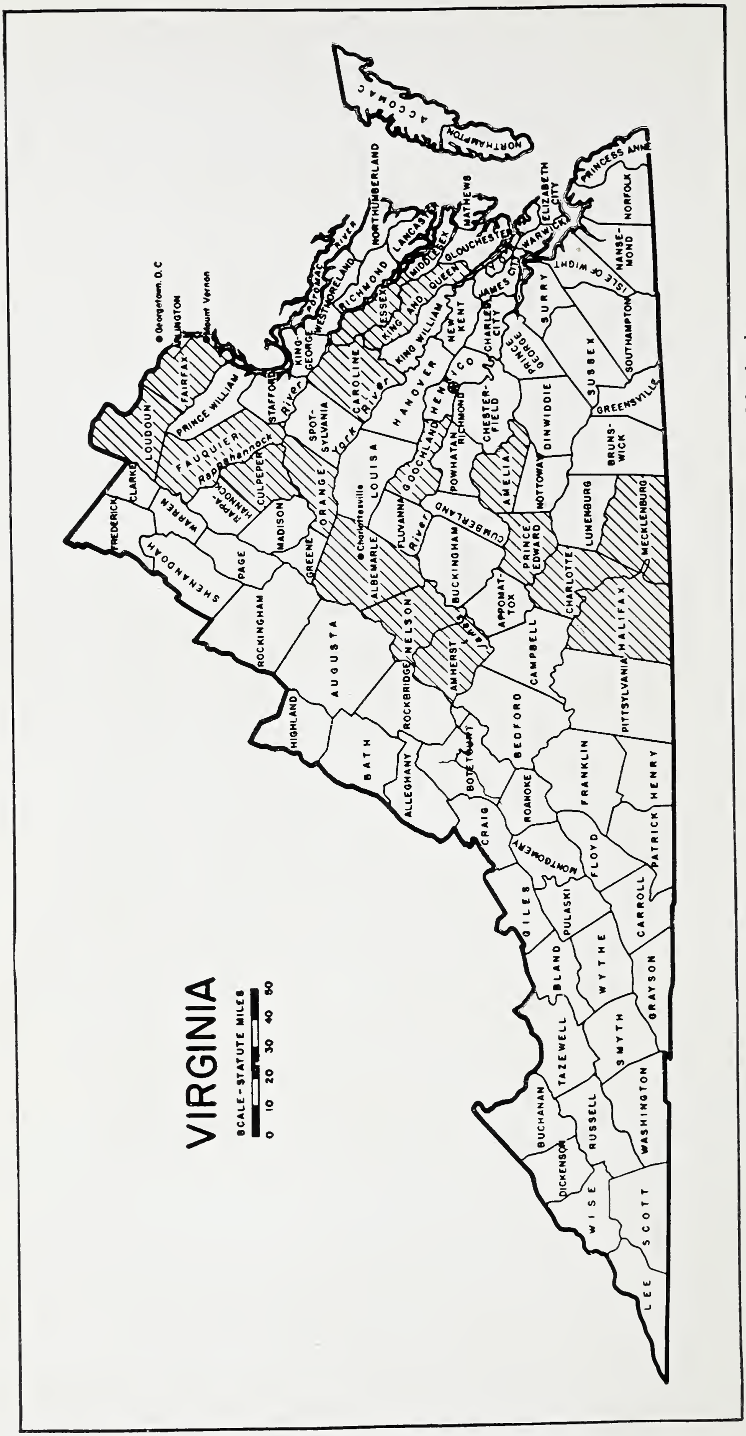

FIGURE 1.—Map of Virginia. All counties mentioned in the text are indicated by hachure.

EARLY EROSION-CONTROL PRACTICES IN VIRGINIA

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FOREWORD

During recent years, for the first time in American history, various governmental agencies have given serious and concentrated attention to the problem of culturally induced erosion. For this reason it is commonly assumed that the problem is a new one. Mr. Hall's study reveals that, on the contrary, American farmers individually have been fighting soil erosion for at least a century and a half.

It is probable that the Virginia planters were troubled with soil wastage as soon as they began to till lands with any considerable degree of slope. By the end of the eighteenth century culturally induced erosion had made great inroads into the agricultural resources of the State, and attempts to control it were beginning to be made. Most of the erosion-control practices in use at the present time, such as the use of legumes and grasses, deep plowing, contour plowing, and hillside ditching, the prototype of modern terracing, were either developed by the Virginia farmers or became known to them during the first half of the nineteenth century.

If these various practices have been known for so long a time, why is it that they have not been more effective in promoting soil conservation? The answer to this question is found in the lack of agricultural organization of this earlier period. Farming was then the most highly individualistic of enterprises. Coordinated effort in agricultural research was in its embryonic form, and its representatives were the several voluntary county and State agricultural societies. Among the documents of the Virginia legislature for the period of the 1830's and 1840's are a number of petitions from these societies for governmental aid to farmers. As early as 1803 Thomas Jefferson recommended the introduction of agricultural education, and when plans were drawn up for the curriculum of the University of Virginia he urged the establishing of a chair of agriculture. However, no effective assistance was given to the farmers, and plans for the teach-

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ing of agriculture at the University of Virginia were not approved by the State legislature. Each farmer was left to his own resources and conducted his own experiments in erosion control. Others might advise, but he alone was responsible for his methods and the judge of his results. Such attempts to prevent or control erosion as were made were often haphazard or superficial. Contour plowing, hillside ditching, or proper crop rotation might be given a hasty trial and discarded, not because they were inherently defective, but because the experimentation necessary to perfect the technique had not been performed, or merely because of prejudice in favor of the old methods. Many were unconcerned about soil wastage because of the relative abundance of land. Thus the community was either indifferent or divided in opinion as to the best soil-conservation practices.

Little headway could be made against erosion under these conditions. Soil wastage has accordingly proceeded until the problem has reached a crisis. The State agricultural experiment stations and the Federal Department of Agriculture began to study erosion about the beginning of the present century. The work of these different agencies has now been brought together and expanded by the Soil Conservation Service, in cooperation with landowners and operators. A coordinated and unified defense against culturally induced erosion, an ideal never realized by the early agricultural societies of Virginia and other States, is now possible of achievement. No longer is the vital question of erosion left to be solved by the sporadic efforts of scattered individual farmers.

H. H. BENNETT.

THE EROSION PROBLEM AND ITS RECOGNITION IN COLONIAL AND EARLY NATIONAL TIMES

Patrick Henry is said to have remarked on one occasion soon after the Revolution that "'since the achievement of our independence, he is the greatest patriot, who *stops the most gullies*'" (*66, p. 586*).[1] The statement was indicative at once of the existence of a serious erosion problem by that date and of its recognition by farmers and statesmen. Abundant agricultural land in proportion to a sparse population, a type of farming based on one staple crop, and a theory of commerce that subordinated the needs of the colony to the desires of the mother country all combined to bring about a "mining" of Virginia's soil in the colonial period (fig. 1).

Tobacco, the great staple of commerce, and Indian corn, the great feed crop, were both clean-tilled crops. In both tobacco and corn cultivation the soil was hilled up about the plants with the hoe, or for the latter crop stirred superficially with the light, one-horse shovel plow. In either case the tillage left the soil in a condition susceptible to washing by the heavy summer rains. Virgin lands just cleared of the forest were planted to tobacco for 3, 4, or 5 years until they would no longer yield a profitable crop. They were then either abandoned at once or planted to corn for a number of years until that crop would no longer pay for the labor devoted to it. After this ruinous course the lands were abandoned to broomsedge.

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[1] Italic numbers in parentheses refer to Literature Cited, p. 26.

thickets, and gullies. In the meantime new lands were being cleared only to be subjected to the same exploitation. By the process of clearing and abandonment, this destructive tobacco economy marched through Tidewater Virginia and most of the Piedmont during the century and a half of the colonial period.

Although soil exhaustion came to be regarded as normal by Virginians, complaints against it were not lacking. Some substitute for tobacco as a staple crop was constantly being sought. Toward the end of the eighteenth century many sections of the State where virgin tobacco land was growing scarce or where the soil was unsuitable for tobacco found this substitute in wheat. Although it was less exacting in its soil requirements than tobacco, the Virginia farmers were just as injudicious in its cultivation. Lands were cropped in wheat and other small grains or wheat and corn continuously until they were considered completely worn out (*43, v. 1, pp. 445–446; 49 p. 108; 73; 51, v. 3, p. 142*).

It is more than likely that the soil exhaustion complained of by Virginians from the earliest times was due as much to erosion as to other factors. The planters who early settled along the James River had occasion to complain of the destructive freshets of that stream. In 1685 the first William Byrd described one such deluge that carried away the tobacco hills "with all the top of the manured land." Concerning a flood in 1771 another observer (*61*) wrote:

> * * * Worst of all is the Loss of Land—in many places on the low grounds the soil is entirely gone—all the Fences, together with the Tob'o that was planted thereon * * * Mr. Walter King of Bristol has lost in soil only at least nine thousand pounds.

Throughout the latter part of the eighteenth and the beginning of the nineteenth centuries there were increasing comments on the destructive effects of erosion. As early as 1769 George Washington was conducting experiments at Mount Vernon to determine "whether the land was not preserved more by harrowing than by lying in furrows" (*35, v. 1, p. 347*). Nevertheless the Father of his Country continued to be troubled by soil washing during the remainder of his career as a planter. Referring to the Mount Vernon estate a quarter of a century later, he wrote (*22, p. 83*):

> The soil of the tract * * * is a good loam, more inclined however to clay than sand. From use, and I might add, abuse, it is become more and more consolidated, and of course heavier to work. * * * A husbandman's wish would not lay the farms more level than they are; and yet some of the fields, but in no great degree, are washed into gullies, from which all of them have not as yet been recovered.

This letter was writen for the purpose of attracting English tenants to his land. The measure of his discouragement with farming may be judged by his writing thus in a sales letter! In fact, much of the land of Fairfax, Washington County, was a drug on the market during the last decade of the eighteenth century because of its gullied condition (*7*).

Richard Parkinson, an Englishman who was attracted to Mount Vernon by Washington's offer, noticed other gullied and washed lands along the Potomac in the vicinity of Mount Vernon. This phenomenon of soil wastage was quite novel to Parkinson. He noted that it was caused by the frosts of winter followed by the hasty showers or "gusts" of summer, and that the land was often cut into gullies 10 feet wide and 10 feet deep, or was eroded into the form of a hole having the appearance of a stone quarry. This stranger to American agricultural requirements had some disheartening experiences with erosion on a farm that he purchased near Baltimore. He found that the land in tillage could not be pulverized. On land treated in this way (*70, v. 1, p. 45; v. 2, pp. 481–482, 489, 493–494*):

> * * * the whole of the soil [moved], for an acre together, when a heavy rain fell, from the current in some places cutting gullies, and carrying part of the manure away; and the soil seemed to press in or slip after it.

The Tidewater areas were faced not only with the problem of washing on the uplands and flooding in the stream valleys, but also with that of silting in the stream channels themselves. Very little was done in the way of draining or improving the lowlands. Instead, the uplands were farmed in such a way that the productive silt was washed downhill, thus ruining both uplands and lowlands. John Taylor of Caroline County, an acute observer of things agricultural as well as things political, writing in 1813, deplored this condition (*84, p. 246*). He said that few of the channels of the seaboard streams retained any appearance of their natural state, "being everywhere obstructed by sands, bogs, bushes, and rubbish, so as to form innumerable putrid puddles, pools, and bogs upon the occurrence of every drought * * *." Taylor (*84, pp. 172–173*) saw clearly that there was more than one reason for viewing the erosion problem with alarm.

> The disaster is not terminated by the destruction of the soil, the impoverishment of individuals, and the transmission of a curse to futurity.—Navigation itself is becoming its victim, and in many parts of the United States, our Agriculture has arrived to the insurpassable state of imperfection, of applying its best soil to the removal of the worst farther from market.

As the farmers of Virginia advanced from the Tidewater into the more rolling land of the Piedmont they made few agricultural adaptations to the different environment. Corn continued to be "cross plowed" regardless of the situation of the field, one furrow being conducted up and down the slope for every one that crossed it (*24, p. 11*). The results were not long in becoming apparent. An English officer held captive at Charlottesville and Richmond during the Revolution noted in 1779 that soil washing in the lands of the upper Piedmont caused the James River to look like a "torrent of blood" in times of high water (*17, v. 2, p. 360*).

We may infer that by 1790 the process similar to that by which Cecil sandy loam has been converted into Cecil clay loam over large areas was largely completed in Amelia County. Such an interpretation might be placed upon the remarks of Meriwether (*57, pp. 35–37*), who said that the gray surface soil of much of that county had been swept away, leaving the subsoil of hard, tenacious, red clay exposed.

The inroads of erosion in the region adjacent to the Blue Ridge notably on soils of the Davidson series (the "red lands"), was especially disquieting to those early Virginians, because this region had the reputation of being one of the richest agricultural areas in the State. William Strickland, an Englishman sent over to examine the agriculture of the United States, had this to report of the area in 1796 (*83, p. 205*):

> A richer district by nature there cannot be, than all those counties which lie at the eastern foot of the Blue Ridge; but, like whatever on this continent has been long cultivated they are nearly exhausted.

Years later those remarks were confirmed by Craven (*29*) of Albemarle County. He wrote that in 1799, when he first came there, the "red lands" were worn out, washed, and gullied, and presented an impression of nakedness.

In 1817 Thomas Jefferson, of the same county, commented that "fields were no sooner cleared than washed" (*36 v. 12, p. 56*). Madison (*55*) declared 2 years later that without the use of soil-saving methods of cultivation, the ownership of "red lands" was little more than a lease for years. Nevertheless, farmers of the lower Piedmont could also make the same complaint. That voiced by one (*89*) from Prince Edward County in 1838 is less striking but more specific than Madison's. He estimated that the destruction by washing had been so general that very little hilly land cleared for more than 20 or 30 years was of any value.

There was some difference of opinion as to which crop, if any particular one, was most destructive of soil resources. Corn, tobacco, and even wheat, each received a share of the blame for soil wash, but the first named was usually declared the major villian. Washington, Jefferson,[2] and others complained of the "ravages" of corn on the soil. To be sure, tobacco was very exacting in its chemical requirements, but it was generally planted in small patches, whereas cornfields took up a larger part of the area of the farm. Tobacco was often "manured" with decaying leaves and trash, whereas corn was plowed frequently and the ground left bare (*72*). Perhaps the practice in Halifax County in the 1830's was typical of the entire tobacco region in the early nineteenth century. No land except that intended for tobacco was manured because of the danger that rains would wash the manure away. A small, level place free from erosion was accordingly selected to be planted to tobacco year after year, while the unmanured crops were left to the more exposed hillsides (*23*). Thus, the nature of the crop practice prevented tobacco from wreaking the destruction attributed to corn. The opinion was widely held that tobacco was harmful principally because it took most of the farmer's attention, leaving little time for the improvement or preservation of land in other crops. At any rate it was believed that land in tobacco rarely showed signs of washing, one author holding that the "vegetable mold" or topsoil of the tobacco patch disappeared more by a process of evaporation than in any other way (*41*).

It was an easy and popular attitude that blamed the principal crops for the soil wastage, but there were at least two writers who declared that the farmers and planters themselves were not entirely guiltless. One of these was John Taylor. The other was Thomas Moore, of Maryland. Moore (*60*) was among the first to take a comprehensive view of culturally induced erosion and its causes in the South. His voice was raised in warning against the insidious process of sheet wash that was depriving the farmers of the cream of their soil. Freshly cleared lands did not lose much soil the first year, he said, since the undecayed vegetable matter held it in place; but because of the prevailing practice of shallow plowing, rolling lands were usually attacked by erosion the second year. The plowing referred to did not extend to a depth greater than 4 inches and did not afford sufficient loose earth to absorb the water. Each successive plowing brought up fresh mold to be swept off in its turn, according to Moore, the result being that throughout the hilly country of the Southern States the surface of the soil was then (1801) the whole depth of plowing lower than when the land had been first cleared. The proofs cited for this assertion were the half-buried posts in low places and the silting taking place in creeks, millponds, and the heads of rivers.

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[2] Thomas Jefferson to T. M. Randolph, Philadelphia, Aug. 11, 1793; George Washington to Thomas Jefferson, Mount Vernon, Oct. 4, 1795; Thomas Jefferson Papers, Library of Congress.

> Thus the land becomes sterile not so much from the vegetable nutriment being extracted from the soil by the growth of plants, as by the soil itself being removed; that this is a necessary consequence of *shallow ploughing*, on lands that are in any degree hilly, in this climate, I trust, has been satisfactorily proved. * * * what further proofs need we, to convince us that the practice of agriculture, particularly in the southern states, is miserably defective, than the deserted old fields that so frequently present their disgusting surfaces from Susquehanna to Georgia? Some years ago, I was of opinion that this speedy reduction of soil, was altogether occasioned by the nature of the crops cultivated thereon; but, on attending more accurately to the subject, I am of a different opinion, and believe * * * it is more from the manner of cultivation than from the exhausting properties of the crops * * * (*60, pp. 13–16, 27–28*).

Enough has been said to show that the erosion problem was present in colonial times and that by the beginning of the nineteenth century it had become a matter of considerable concern to some agricultural writers. The erosion problem in itself would perhaps not have caused so much perturbation, had it not been for the prolonged agricultural depression of the close of the eighteenth and the beginning of the nineteenth centuries. The increasing scarcity of virgin tobacco lands, the declining yields from the old areas, the low price of tobacco, and the highly unstable character of the wheat market forced the Virginia farmer to make readjustments. He could either abandon his tired and worn fields for fresh lands in the West, or he could begin a course of improved and more intensive farming on these same old fields.

Far too many agriculturists chose the former course. The existence of the vast unoccupied West thus acted as a deterrent to any improvement at home. "* * * the scratching farmer's cares and anxieties are only relieved by his land soon washing away. As that goes down the rivers he goes over the mountains" (*1, p. 25*).

Nevertheless, certain forward-looking members of the agricultural community initiated a reform movement in agriculture. This movement stressed proper crop rotations, the use of animal, vegetable, and mineral fertilizers, and the prevention and control of erosion. Farmers of liberal education who operated on a rather large scale were the principal leaders in this movement (*28*). They were the moving spirits in the agricultural societies, as they were the founders and supporters of the agricultural press. It is their records which the modern agricultural historian must consult, for the great body of small farmers did not write of their operations. To a very great extent the latter group seems to have been content to continue in the old way of doing things, professing a great contempt for the "book farmers." No doubt it was also true that soil wastage was especially bad on the smaller holdings, since the larger estates had a greater amount of uncleared land or other surplus ground reserved for future exploitation (*25, p. 147–148*). If the resources of a large estate were wasted the improvident management of the overseer was generally blamed.

On the other hand, one must not get the impression that all the great landholders were bearers of the light while all the small farmers and the overseer class were content to remain in darkness. The small Quaker farmers of Loudoun County gained the reputation of being among the best agriculturists of the State. Nor could overseers be blamed if absentee or amateur owners demanded large immediate returns regardless of the ultimate results to the land.[3]

Stated generally, the problem of renovation was to restore productivity to old worn-out and eroded fields and to maintain productivity on these fields. The problem of restoring gullied surfaces had been brought to the public attention at least as early as 1788 in Pennsylvania. In that year the Philadelphia Society for Promoting Agriculture published a list of prize awards, one item being the following (*91, v. 3, p. 269*):

> For the best method, within the power of common farmers, of recovering old gullied fields to a hearty state, and such uniformity or evenness of surface as will again render them fit for tillage; or, where the gullies are so deep and numerous as to render such recovery impracticable, for the best method of improving them, by planting trees or otherwise, so as to yield the improver a reasonable profit for his expenses therein, founded on experiment, a gold medal; and for the next best a silver medal. To be produced by the 1st of January, 1790.

Similar to this was the questionnaire published by the Richmond Agricultural Society (*76*) in 1811 asking for information on these subjects:

> 1st. The best mode of restoring worn out land, filling gullies, and bringing it in order for the plough.
>
> 2nd. The best rotation of crops in which Indian corn, wheat and clover are included. * * *
>
> 3rd. Do. In which tobacco, wheat and clover are included. * * *
>
> 7th. The best mode of preventing lands under the plough from washing. * * *
>
> 9th. The best method practicable on a large scale, of bringing exhausted lands into a condition to bring clover.

There were 84 questions in this list. That the problems of restoring worn-out and gullied fields and of preventing other cultivated fields from washing further should occupy first places on this list indicates their importance in the minds of these Virginia farmers. Forward-looking members of the agricultural community attacked this problem with intelligence and ingenuity, with the result that many devices for the prevention and control of erosion were worked out. Some of these devices had their American beginnings in Virginia. The State became a great laboratory in which many different methods of restoring washed lands were tested. Many workers then discovered facts that the erosion experiment stations, by more careful methods, are rediscovering today. The remainder of this publication deals with the various techniques developed at this early time.

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[3] See, for instance, correspondence between plantation owners of Amherst County and their overseers, Ambler deposit of mss. University of Virginia Library, 1923–24.

ELIMINATION OF GULLIES AND GALLS

If crops were again to be raised on fields where broomsedge had taken the place of corn, and gullies had replaced furrows, some means must be found to restore the land so that washing would not be resumed. With progressive farmers and planters this was an important desideratum. George Washington informed his overseer in 1795 that immediate profit was not so much an object as the bringing of worn-out and gullied fields into a condition to bear grass (*27, p. 158*). Much of the land at Mount Vernon would not yield grass "kindly",[4] but the General did not wait for grass to take a field without aiding the process of recovery in other ways. When fields became broken and washed they were retired from cultivation, smoothed with the harrow, covered with straw, weeds, or other "vegetable rubbish" to prevent further gullying, and left to resume the process of natural recovery (*22, p. 109*).

In the filling of gullies the great difficulty was to hold the material in place and to prevent further washing. Gully dams of various types were tried. Some were of stone, some of woven limbs or wattle, and some of transverse logs. Such contrivances, unaided, were open to the criticism that water, in falling over them, cut the earth below, and so accelerated the gullying. Some farmers seem to have regarded stone dams as especially open to this objection (*64*). Wheat straw, brush, and small dead trees might also be placed behind the dams in the larger gullies or used alone when the gullies were of smaller dimensions. Evergreens, still having the needles on the limbs, placed with the branches pointing up the gully, were recommended for this purpose. Care was taken not to destroy or break with the plow any grass which might begin growth in the gully.

Farmers not content to wait for the slow natural process of gully healing could speed the work by partially filling small gullies with dirt, rubbish, or ashes. An effective way of accomplishing this was to plow the sides parallel to the gully and throw the dirt inward. The method adopted by one enterprising farmer was perhaps typical of many others. He hauled dirt from fence ways, turning rows, and other vacant places to fill his small gullies and other barren spots (*11, 26, 56, 69*).

The term "gall" or "gald" has long been applied to barren, unproductive spots from which the topsoil has been washed. Plowing and harrowing were often not enough to restore these spots to productivity. Thick coatings of straw or leaves were frequently left to rot on the galls and then plowed in to aid in producing a new tillable soil on the barren area. Edmund Ruffin, the advocate of lime as a cure-all for the agricultural ills of eastern Virginia, admitted that lime alone would have little effect on the "acid hilly land" of that section, for good done would diminish in proportion to the amount of soil previously removed. To restore fertility to galled spots, he (*77, p. 53*) recommended a combination of lime with putrescent manure. This, he said, would aid soil to form on such spots from vegetation brought in by the wind.

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[4] George Washington to Thomas Jefferson, Mount Vernon, July 6, 1796. Thomas Jefferson Papers, Library of Congress.

The most conspicuous culturally induced erosion features of the Piedmont area are the gullies caused by old roads. The sites of many of these are now marked by ravines completely covered and healed over by matured forest growth.

Gullying, both on public and on farm roads, was a source of trouble at all times. To combat it Meriwether (*57, pp. 19–20*), of Amelia County, devised a pair of cart wheels with 10-inch treads to be used for hauling crops out of the field, carting manure, and performing similar tasks. Two narrow-wheeled carts and a wagon were also used, but the broad-wheeled cart always followed the others to level their tracks. Meriwether began using these wheels about 1798 and not only succeeded in preventing gullying in roads but smoothed over several roads that had previously been gullied.

At a later date, when interest in public roads had become more widespread, some attempt was made to prevent the wearing away of these thoroughfares. Brush was sometimes placed in the ditches on either side of the road but it was found that this might result in the gullying of the road itself, until it was lower than the ditches. This difficulty prompted the novel suggestion that a hillside road cut should be allowed to wash deeper and deeper until the road on the hill was level with the road in the valley (*16*). Roads were thus to be allowed to grade themselves.

THE USE OF GRASSES AS SOIL BINDERS

Eighteenth century Virginia husbandmen, in common with those of England, believed that it was undesirable to leave the ground exposed to the rays of the sun. Those who attempted to improve their land used various legumes, grasses, and clovers primarily as shade crops. Those crops were also esteemed because they were thought to draw "atmospheric manure" into the soil and because their roots and straw prevented the soil from washing.

John Taylor incorporated the idea of grasses as soil binders and improvers into his famous system of agriculture. Others had deplored the damage done by clean-tilled crops such as corn, but Taylor was the first to work out a constructive plan to ameliorate the evils. He advocated a rotation of crops to consist of corn, wheat, and 2½ years of rest, or "enclosure", on any one field. While the field was enclosed it was not, in Taylor's mind, lying idle, for it was to be allowed to grow up to white clover and other volunteer perennials. When plowed under, the fibers of these plants would create "covered drains" and prevent washing while the land was in corn.[5] Later he came to regard meadow oat as the best grass to prevent erosion (*85*).

Clover and redtop, or as it was often called in Virginia, herds grass, were the two most popular soil-preserving crops of ante-bellum Virginia. Taylor considered that the clovers were more satisfactory in the section just east of the Blue Ridge than in the exhausted lands of the lower country. White clover the farmers already had at hand. It was the first plant to cover a newly abandoned field, although it was succeeded the second year by sassafras and brier bushes (*83, p. 263*). Red clover was apparently introduced from Pennsylvania and was first used by the Quaker farmers of Loudoun County. Israel Janney and John A. Binns started raising it with the aid of gypsum as a fertilizer in the late 1780's (*25*, p. *164*). By the 1830's the use of these twin improvers, red clover and gypsum, had spread throughout the upper Piedmont counties of Fauquier, Orange, Albemarle, Nelson, and Amherst. By their aid and by the practice of deeper plowing much was done in the way of restoring fertility, smoothing over old washed fields, and preventing the formation of new gullies (*56*). Gypsum was thought of not only as a fertilizer for the clover but was itself considered as an agent for preventing the soil from washing. Thomas Moore believed that its effect was to a certain extent the same as that of deep plowing in that it opened the soil to a sufficient depth to permit the absorption of heavy rains.

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[5] John Taylor to Thomas Jefferson, Caroline, Mar. 5, 1795. Jefferson Papers, Library of Congress.

Jefferson placed great hopes in clover. In order to reduce the acreage devoted to corn he tried substituting potatoes, red clover, and sheep for corn and hogs. He found that this could not be done in any economy in which corn meal and pork were the principal items in the diet of the laborers. Nevertheless, clover sown with gypsum remained an important part of the rotation on the Jefferson estates after 1794 (*52 v. 18, pp. 187–200*).

A system of rotation akin to that of Taylor's was developed in the upper Piedmont area. It consisted of corn the first year, wheat the second, and red clover the third and fourth. Probably here, as in Halifax and Mecklenburg Counties, tobacco was reserved for one particular spot on the farm, but it was recognized that a rotation on tobacco lots was a desirable type of management. A system of rotation recommended by one writer for Nelson and Amherst Counties in 1837 consisted of tobacco the first year, wheat the second, and clover for 2 years thereafter. This, together with various mechanical devices for conserving the soil, was believed necessary if tobacco was to continue as a staple commodity of that section. The forested land could no longer be relied upon to furnish virgin tobacco soil for even then, in many instances, the wood lots were too small for the support of the farm (*10*). The farmer who expressed this opinion may have taken too pessimistic an attitude, for others believed that the old fields cleared of their second growth of pine, if given a judicious rotation, produced the finest quality of tobacco (*56*).

Redtop was another crop introduced from Pennsylvania. Senator Abraham Venable, of Prince Edward County, is said to have sent a parcel of seed to Virginia from Philadelphia while the Federal Government was located there. In the Piedmont it could be used on highlands too badly exhausted for clover (*92*); it was believed that redtop prepared the ground intended for tobacco better than did clover (*53*); as a soil binder it was also found superior, since its roots gave the land a stronger turf and it would continue to thrive for a longer period (*63*).

Other grasses were used or recommended as the particular "pets" of certain farmers. Orchard grass was found to do well near Beaverdam, Hanover County, but was not to be recommended for the "red lands" or the light sandy soils of lower Virginia (*71*). In Prince Edward County it was observed that the spontaneous growth of crabgrass did much to retard the destruction of land brought about by shallow plowing. The principal draw-back to the use of this as well as other grasses native to the section was that they were annuals. Hence, it was necessary to raise the introduced perennials (*89, p. 754*). For the sandy rolling lands of eastern Virginia one correspondent (*12*) of the Southern Planter recommended the wire grass (Bermuda) as a soil binder, remarking that "Virginia farmers can kill everything else with which dame nature has furnished them, except mules and wire grass * * *."

LAND RETIREMENT

In 1834 the complaint was made that the tendency to till as many fields as the planter's labor supply would permit, regardless of the fertility of those lands, had resulted in much unprofitable farming, especially in the hilly lands. Why should uplands be manured when the first rain might sweep both soil and manure away (*65*)? To cultivate more of the bottom lands and allow the hillsides to rest, then, was the object of many. In the 1820's Minor, of the Albemarle Agricultural Society, conducted some experiments in manuring corn with a view to establishing permanent manured cornfields on the flats so the hillsides could be relieved of this exhausting crop (*57, pp. 44–45; 58*). It seems that the practice of limiting corn to the lowlands was carried out by other farmers as well (*14*). One farmer (*72*) of Wardsfork, Charlotte County, advocated the planting of hillsides in grass, orchards, or wheat and reserving the valleys for the cultivated crops.

What was to be done with the hillsides retired from cultivation? The history of agriculture shows that a succession of lands have been retired from cultivation in Virginia—not for the purpose of preventing washing, indeed, but simply because they were already too badly gullied or otherwise exhausted to bear more crops. However, there were those who advocated a deliberate policy of turning out fields that were too steep for profitable cultivation that they might reclothe themselves with forest growth by the natural process of plant succession (*19*). Such a policy of permanent retirement had its strict limitations, at best, for farming must continue to be profitable.

The use of this land for pasture naturally suggested itself, but doubts were entertained that this would be a better way to preserve the soil than was cropping. One writer believed that the hoofs and teeth of cattle were second only to the washing rains as destroyers of land (*66*). Taylor had emphasized the point that livestock should be kept out of the enclosed fields that were resting under a grass cover. Nevertheless, he would have had the farmers maintain permanent pastures, to provide for fertilizing the cultivated fields. Some agricultural writers, on the other hand, advocated that farmers should reduce their number of livestock and depend upon artificial fertilizers and grasses to restore their land (*21*). Perhaps part of the distrust of livestock was due to the traditional colonial habit of keeping only a small number of cattle.

As time went on an important school of opinion grew up, holding that properly conducted grazing was the best use for grass crops. In 1847 a writer declared that low stream bottoms and steep hillsides should be kept in perpetual grass to prevent the soil from washing away and that these situations should be used only for pasture. The pastures should be periodically restored by the application of gypsum, ashes, salt, lime, or crushed bone to return to them the substances taken away by the animals and the washing rains (*13*).

The advantages of pasturage were eloquently set forth in a speech of Morton (*63, p. 131*) before the agricultural club of Mecklenburg County in 1843:

> Is there not something humiliating in having our eyes, whenever we ride or walk into our fields, greeted with the yawning gall, or the more hideous gully? Or meeting by the wayside, the kine of Pharaoh, who, having devoured all the miserable trash and weeds, which mar the beauty of our fields, are themselves, just about to be devoured by the buzzards? How do these scenes contrast with the verdant grass springing up in all its vigor and luxuriance, and clothing our fields in its beautiful habiliments; with the cattle of a thousand hills grazing bountifully through the day, and returning home at eve laden with deposits, richer than those of the *mammoth bank*, and laying their grateful tribute at the master's feet, and causing his table to groan under the teeming abundance of milk, butter, cheese, and beef?

INTERPLANTING

Various ways of leaving parts of the field in grass while the remainder was cultivated were tried out, but they do not seem to have been successful. In 1814 a certain James Hall secured a patent for a method of planting corn in an unplowed field. He marked off the land in squares, each square being of certain dimensions and a certain distance from its neighbors and containing a given number of cornstalks. Only these squares were cultivated, manured, and mulched, the rest of the field being allowed to remain in grass. A number of Albemarle County farmers found this method a complete failure because of the inability of the corn to withstand dry weather. Jefferson's was the only experiment that approached success, but even his corn suffered from drought.[6] Some farmers left a strip of turf unplowed between the corn rows, throwing the dirt to the row by the operation of listing the corn in cultivating it. This was done not only to prevent washing but also to lessen the danger from cutworm, since it was believed that the insects would eat the grass and to a certain extent spare the young corn. However, this practice was frowned on by others as being a slovenly method of cultivation and as being open to the same objection as was Hall's method (*20, 65*). Washington and Jefferson adopted the practice of alternating rows of potatoes or some other vegetable with rows of corn (*35, v. 3, pp. 187, 377–378*).[7]

METHODS OF PLOWING AND CULTIVATING

Progressive farmers realized that the customary methods of cultivation should be improved greatly if erosion was to be minimized. The object of Thomas Moore in writing his book was to combat the prevailing practice of shallow plowing.

Shallow plowing was partly the result of poor implements. The principal type of plow used in colonial and early national times was the light, one-horse shovel plow. After the introduction of heavier two- and three-horse moldboard plows made of iron the plowing could be deeper, but many farmers continued with the old instruments and in the old ways. They believed that to plow deeper than 3 or 4 inches would mean the turning up of the "dead earth" of the subsoil, thereby injuring the topsoil. Nevertheless, most of the systems of farm improvement, such as Taylor's or that practiced in Loudoun County included deep plowing as one of the remedies for soil washing. Jefferson wrote (*52, v. 18, p. 278*) to a friend:

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[6] Hall's patent and specifications, Nov. 19, 1814. P. Minor to General Cocke, Ridgeway, July 15, 1815, Cabell Mss., Va. State Library; Jefferson to Charles W. Peale, Monticello, Mar. 21, 1815, Jefferson papers, Library of Congress.

[7] Thomas Jefferson to T. M. Randolph. See footnote 2.

> Ploughing deep, your recipe for killing weeds, is also the recipe for almost everything good in farming. The Plough is to the farmer what the wand is to the sorcerer. Its effect is really like sorcery.

The Davidson soils of Jefferson's county were found to be admirably suited to deep plowing. In 1825 it was said that the average maximum depth of plowing in Albemarle was 6 inches, but that a depth of from 8 to 10 inches was preferred where the strength of the horses and the type of plows would permit it (*59*). In Loudoun County 12-inch plowing was attained with plows drawn by three, four or even five horses (*30, 68*).

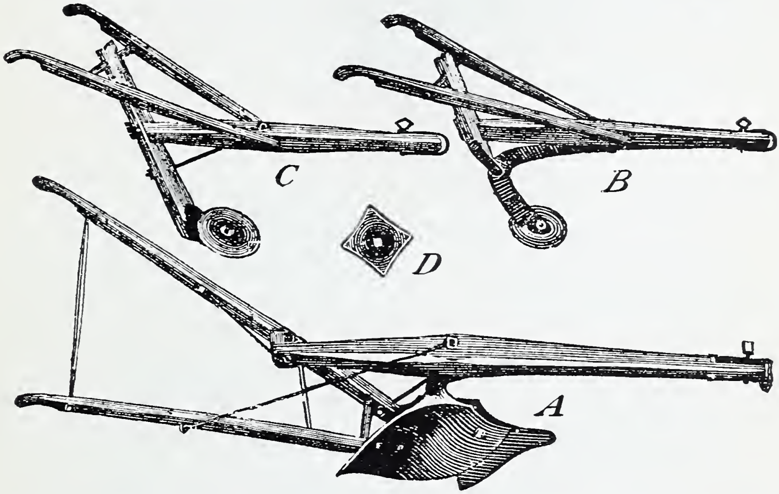

FIGURE 2.—Plows manufactured by Gideon Davis: *A*, Bar-share plow; *B*, substratum plow; *C*, shovel plow; *D*, square type shovel for plow.

A simple turning plow designed to penetrate to such depths was not considered adaptable to much of the soil of the tobacco districts of Halifiax County or the wheat districts of the northern part of the State. In general these soils were described as having a thin sandy topsoil with a clayey subsoil (*75*). To bring this stiff clay to the surface was considered as merely accelerating erosion, since the clay would form a cement when the first heavy rain fell, thus preventing the water from being absorbed. If some means could be found by which the tough substratum could be broken without bringing it to the top, the water-absorbing capacity of these soils would be greatly increased and erosion lessened. Some farmers ran colters deeply in the furrows following the turning plow to effect this objective. The substratum plow designed by Gideon Davis, an implement maker of Georgetown, D. C., was simply a refinement of this colter. This plow consisted of a long tongue of iron to which was attached a cutting disk or point (fig. 2). This, like the colter, was to follow in the furrow made by the turning plow. The topsoil was in this way turned over and the subsoil broken without disturbing the relative position of either. The two plows together were supposed to break the ground to a depth of about 1 foot (*31, 32*). The substratum plow was introduced in Virginia about 1822 and soon became a popular farm tool.

The method of plowing and cultivating was as important as the depth of plowing. By the end of the eighteenth century some farmers were discontinuing the old method of ridging or hilling their crops. Jefferson and his son-in-law, Thomas Mann Randolph, decided that the washing of land in corn, potatoes, or peas would be lessened by dressing the ground out flat. John Taylor also practiced this method in cultivating corn on his Caroline County farm. To prevent washing on hilly potato land he ran his drills across the face of the hill with a double moldboard plow, trod manure into the furrow on top of the potato slips, and covered the furrow in the direction opposite to the one in which it had been opened. When laid off in this manner the potato rows themselves served as drains to carry off excess water.[8] Meriwether of Amelia County was another advocate of flat tillage. Writing in 1818 he recommended that on "gray land", such as his, the soil be broken 6 inches deep and after planting, harrowed out smooth. A straight-toothed triangular drag 3 feet wide containing 13 teeth was the implement used for this operation. Meriwether attributed the disposition of his ground to wash less than that of his neighbors to this method of cultivation (*62*).

HORIZONTAL PLOWING

Horizontal or contour plowing was another method of plowing and cultivating appropriated and developed by early Virginians in order to prevent erosion. The customary usage of cross plowing the corn was poorly adapted to the rolling country of the Piedmont. Plowing up and down slope was open to at least three objections: It was so difficult that it caused the ground to be worked very superficially; it opened channels by which the soil was carried off directly down the slope; and it failed to preserve the moisture. For these reasons the summer rains were doubly destructive when followed by drought, as was often the case. Some farmers modified the cross-plowing practice by inclining the furrows at an angle of 45° from either direction, but this was insufficient to prevent soil and moisture losses (*24, p. 11*).

Plowing horizontally or at a slight inclination down the slope seems to have been a very old practice in Europe. It was referred to in Roman literature and was advocated by a number of eighteenth century English and Scotch writers on husbandry. Taylor observed in Arator that the "ignorant highlanders" of Scotland had practiced contour plowing for a century. Even the type of hillside plow, supposed by many of his Virginia contemporaries to have been invented by T. M. Randolph, had been used in Great Britain in the eighteenth century. Richard Peters, of Pennsylvania, found that a Hessian soldier who had settled in his State after the Revolution used a heavy hillside plow with a turning moldboard to lay his furrows horizontally, diagonally, or in curves along the hillside. This was the type of plowing with which he had been familiar in the hilly parts of his native land[9] (*8, 88*).

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[8] Jefferson to Randolph. See footnote 2. Taylor to Jefferson, Caroline, Mar. 5, 1795, Jefferson Papers, Library of Congress.

[9] Peters to Jefferson, Belmont, Pa., Mar. 25, 1816, Jefferson Papers, Library of Congress.

There is one mention of horizontal plowing having been practiced as early as 1785 in Essex County, by a Mr. Spindle and his neighbors (*67, p. 744*). Thomas Moore was familiar with the practice and recommended it to overcome the three objections to cross plowing since it aided in deeper plowing, prevented washing, and prepared the land to take advantage of sudden showers. In plowing horizontally on a hillside field the furrow should be turned downhill and the plow returned empty to its starting point to begin the new furrow, advised Moore. If the hill had a conical shape the plow should begin at the bottom and ascend spirally, throwing the furrow slice down all the time.

About 1804 Slaughter (*80*, *81*) of Culpeper County, commenced horizontal plowing with the bar-share plow, an implement in common use at that time (fig. 2, *A*). The corn was listed in rows about 7 feet apart, after which a harrow laid the surface smooth. Slaughter considered that by this means the water was allowed to run over the surface without collecting in channels that would later wash into gullies.

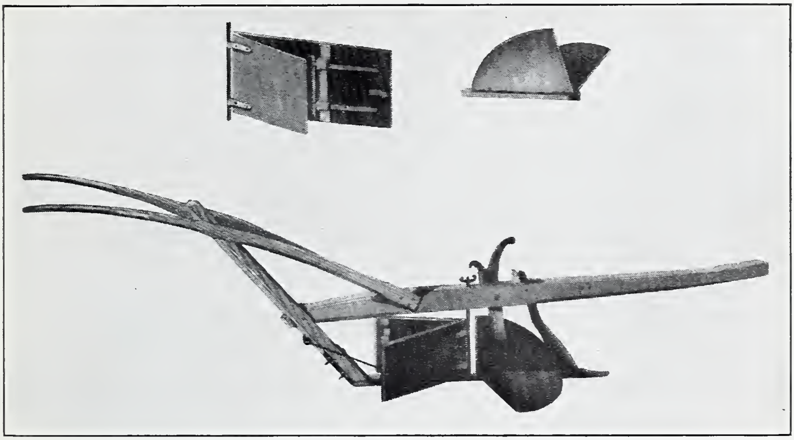

FIGURE 3.—The Randolph hillside plow. Inserts show moldboard (left) and share (right).

Jefferson and Randolph may have received their ideas of horizontal plowing from reading British works on agriculture. If Jefferson observed the practice in France,[10] as has been suggested frequently, he seems to have made no mention of it in his writings. He, himself, always gave the credit to Randolph. The latter, according to his own testimony, commenced the practice of plowing curvilinear furrows for his corn crop in 1793. He adhered to the practice from that time forward, except in the year 1799, when he made one experiment in the old method. Jefferson is said by Randolph to have tried horizontal plowing in 1794 but to have abandoned it after that for a good many years in favor of the old rectilinear furrows. In 1808 Randolph constructed his first hillside plow with a shifting moldboard (fig. 3) (*74*).

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[10] WARD, J. E., JR. THOMAS JEFFERSON'S CONTRIBUTIONS TO AMERICAN AGRICULTURE, p. 56. Ph. D. diss., Univ. Va. Library. 1935.

By 1810 Jefferson had become an ardent believer in horizontal plowing. Describing the results of the method during a certain heavy downpour, he said that on Randolph's farm "horizontal furrows arrested the water at every step until it was absorbed, or at least had deposited the soil it had taken up", whereas on other property the torrents had swept everything before them and greatly injured the fields (*37, pp. 193–194*).

A complete picture of horizontal plowing and bedding as practiced by Jefferson and Randolph is given in a letter from Jefferson to Tristram Dalton, dated Monticello, May 2, 1817 (*36, v. 12, pp. 56–57*).

> A method of ploughing our hillsides horizontally, introduced into this most hilly part of our country by Col. T. M. Randolph, my son in law, may be worth mentioning to you. He has practiced it a dozen or 15 years, and it's advantages were so immediately observed that it has already become very general, and has entirely changed and renovated the face of our country. every rain, before that, while it gave a temporary refreshment, did permanent evil by carrying off our soil and fields were no sooner cleared than washed, at present we may say that we lose none of our soil, the rain not absorbed at the moment of its fall being retained in the hollows between the beds until it can be absorbed. our practice is when we first enter on this process, with a rafter level of 10.f. span, to lay off guide lines conducted horizontally around the hill or valley from one end to the other of the field, and about 30. yards apart. the steps of the level on the ground are marked by a stroke of a hoe, and immediately followed by a plough to preserve the trace. a man or a lad, with a level, and two small boys, the one with sticks, the other with the hoe, will do an acre of this in an hour, and when once done it is forever done. we generally level a field the year it is put into Indian corn, laying it into beds of 6.f. wide with a large water furrow between the beds, until all the fields have been once levelled. the intermediate furrows are run by the eye of the ploughman governed by these guide lines. the inequalities of declivity in the hill will vary in places the distance of the guide lines and occasion gores which are thrown into short beds. as in ploughing very steep hillsides horizontally a common plough can scarcely throw the furrow up hill, Colo. Randolph has contrived a very simple alteration of the share, which throws the furrow down hill both going and coming. it is as if two shares were welded together at their straight side and at a right angle with each other. this turns on its bar as on a pivot, so as to lay either share horizontal, when the other becoming vertical acts as a mouldboard. this is done by the ploughman in an instant by a single motion of the hand at the end of every furrow * * * horizontal and deep ploughing with the use of plaster and clover are but beginning to be used here will, as we believe, restore this part of our country to its original fertility, which was exceeded by no upland in the state.

The rafter level was an instrument commonly used in the South at that time for running drainage ditches, laying off roads in hilly country, and similar work. It was made of two scantlings fastened together at their ends to form an acute angle, a horizontal crosspiece between them, and a plumb line suspended from the apex. The crosspiece was often graduated so that a measured grade could be maintained with each "step" of the instrument if necessary. In order to run hillside furrows exactly horizontally it was, of course, necessary to keep the line on a center mark on the crosspiece as the instrument was "stepped" around the hill (fig. 4).

The prestige of Randolph's name seems to have aided him in securing credit for originating the horizontal culture and inventing the hillside plow. In 1822 the agricultural society of his county awarded him a "piece of plate with an appropriate device and inscription" for this service to agriculture (*87, p. 299*). It has been noted previously, however, that others were practicing horizontal plowing in Virginia about the same time that Randolph started. The real contributions of Jefferson and Randolph were not to originate. but to perfect and publicize this improvement. By doing this work scientifically they left room for others to discover defects and make adaptations to differing situations. By means of his wide correspondence with agriculturists, including among others William Dunbar, of Mississippi, and the members of the Philadelphia Agricultural Society, Jefferson spread the knowledge of horizontal culture to other States (*90, p. 153*).

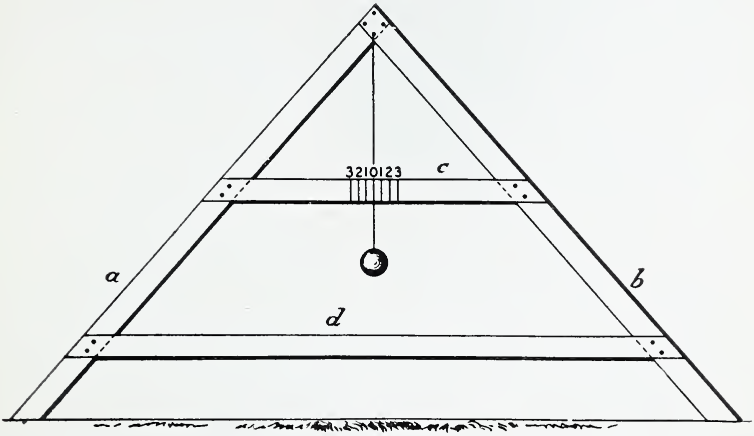

Figure 4.—The rafter level: *A* and *B*, Legs of the level; *C*, scale; *D*, rafter or cross beam.

Jefferson might write enthusiastically about this new practice and presidents of agricultural societies might declaim sonorously about its virtues, but unless the generality of farmers took it up it would do little to preserve the land. The literature indicates that the practice of horizontal plowing had a wide vogue in Virginia. In determining the extent of the practice it is necessary to distinguish between the perfectly leveled horizontal beds such as Randolph used and the less perfect systems similar to Slaughter's.

The care taken by Randolph and Jefferson was not exercised by most farmers. Randolph seems to have been a prophet without honor in his own country for many years. At first the lack of good plows prevented his system being sufficiently successful to induce others to try it. Many criticisms were directed at the hillside plow after its introduction. It was more costly than other plows; it was commonly thought that it would get out of order easily, that time would be lost in shifting the moldboard, and that there were few hills so steep as to make its use absolutely necessary (*5*). Nevertheless, the hillside plow was to be seen before long over a wide geographic range, and improvements were constantly being made in it (*18*).

Various methods were used by those who preferred the less perfect system of horizontal or near-horizontal plowing. Sometimes in laying horizontal furrows with the ordinary plow, when running the plow back in the same furrow it was tilted in such a way that the point would scoop under the unbroken surface. By this means a greater width than the actual furrow could be turned when the next bout was made. Many did not use the water furrow, but adopted Slaughter's method of combining horizontal rows with flat tillage. This method was open to question, for some farmers believed that by allowing the water to sweep over the flat tilled land in a sheet, erosion was merely facilitated, in spite of the fact that the rows were run on the contour (*78*). Those who were not willing to take the pains to use the rafter level trusted to the eye to preserve the contour line. Where fields lay on one side of the hill only and were bordered on either side by narrow depressions running up into the hill the farmer might turn his furrows downhill across the upper part of the field, drag the plow down one depression, turn his furrows uphill across the lower part of the field, and ascend the other depression to the starting point to make the next bout. A serious objection to this way of plowing was that it was very laborious where the furrows had to be turned uphill, and it tended to steepen the slope in this part of the field (*5*).

J. M. Garnett, Jr., of Essex County, noted that horizontal plowing was coming into general use in 1822 but deplored the fact that its efficacy was often counterbalanced by inaccurate methods. In the interests of more accurate leveling he (*39*) suggested a new type of instrument. This consisted of two pieces of timber in the form of a cross. At the top of the longer upright piece a ring was fastened and at its bottom a weight, while sights were placed on the side and near either end of the shorter crosspiece. A long stake could be driven in the ground at a position near the foot of a hill, this instrument suspended from the top of it, and a number of points on a contour on the hillside could be determined by sighting along the crosspieces.

During the 1830's the various methods of horizontal plowing were esteemed by progressive upper-Piedmont farmers as among their most valuable improvements. One Loudoun County farmer believed that deep and horizontal plowing had done as much as clover and gypsum to raise the productivity of the soil there (*63*). In 1834 T. J. Randolph, the son of T. M. Randolph, said that horizontal plowing had assisted in reclaiming the red lands from the desolation wrought by tobacco planters. The surface was again beginning to be smoothed and to produce vegetation. On the other hand, said the younger Randolph, the system was inadequate in many respects. Where exactly horizontal beds were used, sudden rains caused the more soluble lands to become compacted to a degree that hindered absorption, the water furrows soon filled, overflowed into the next water furrow below, and a body of water collected which swept down the hillside, starting a gully. He predicted that the growing practice of cultivating corn on land that had been in clover or grass the previous year would lead to the complete abandonment of horizontal plowing (*6*). Similarly in Fauquier County deep plowing, gypsum, and clover were the main reliances in preventing washing; plowing across the hill slope being considered of only minor importance (*56*).

In spite of the increasing popularity of horizontal plowing, the old method of cross plowing still retained its hold on farmers, while many others tried the new system only to give it up. After a few trials the question was properly raised as to "whether in some climates and soils it has not been so far to fail its purpose as to produce great and lasting injury and if there should not be a slight change in the mode" (*3*).

The criticisms of T. J. Randolph, who lived in the upper Piedmont, have been noted. The Tidewater farmers found the method even less adapted to their soil. Arator recommended horizontal plowing very highly, suggesting that on steep hillsides the ridges or beds should be narrow, their width increasing on more moderate slopes. But later he condemned the horizontal method with faint praise, pointing out that filling the land with vegetable fibers was so far superior to horizontal plowing in guarding against erosion that he considered the latter as an auxiliary only (*86*). A decade and a half after this statement was written Edmund Ruffin was finding that narrow contour beds were entirely unsuited to the sandy soils with low organic content in the Tidewater. More destruction was wrought than if horizontal culture had not been attempted (*9*). In 1837 DuVal, of King and Queen County, wrote the following (*34, p. 180*):

> In riding through the country, ask the date of the enormous gullies which every where intrude upon your notice, and compare it with the date of horizontal ploughing, and you will be satisfied as to the source of the evil.

In summary it may be pointed out that exactly horizontal plowing was criticized because the capacity of the water furrows was often not great enough to hold the water of a heavy rain. When this circumstance did occur and the ridges broke, the accumulated water caused accelerated washing. By tilling the ground flat or by giving the ridges and furrows an inclination this difficulty was in part overcome. Nevertheless, the rainfall during the thundershowers of summer was often too great to be absorbed or carried off clean-cultivated fields. Some other device was needed to take care of the excessive amounts of water falling in a short time.

HILLSIDE DITCHING

The device adopted by Virginia farmers to conduct the excessive rainfall from the field was the hillside ditch. This term was applied to a variety of structures, the essential feature of which was a graded gutter or ditch running across the face of the hill paralleled by an embankment on the downhill side. As used in this publication, the term "hillside ditch" will denote a waterway made with a spade and having a sharp embankment. The term "hillside furrow" will denote a similar structure made with the plow and hoes and having a more rounded embankment, or bed. As used by these Virginia farmers and their contemporaries the words "ditch", "furrow", and "trench" were interchangeable. These hillside structures were the ancestors of the modern terrace.

The same difficulty is encountered in attempting to trace the origin of hillside ditching as is found in the case of horizontal plowing. One southern writer speaks of it as a strictly southern invention, but this statement may be looked upon with considerable skepticism. The Duc de La Rochefoucauld-Liancourt evidently had some such device in mind when he criticized Jefferson's idea of dividing fields by a row of peach trees rather than by ditches. The latter were especially good in a declivitous situation where the soil was constantly being washed down (*51, v. 3, p. 148*). Gov. James Barbour, of Orange County, claimed that he put hill ditches on his farm after an extremely heavy rain in August 1813 had proved to him that horizontal furrows were not always adequate (*20*). Another statement credits a certain Delaplane with having brought the practice to notice about the year 1818. Soon after this, one farmer of Amherst County is said to have tried the plan, given his ditches too great an inclination, and caused gullies in his land 10 feet deep.[11] Humberston Skipwith, who owned a large estate in Mecklenburg County, was given the widest publicity as the originator of the hillside ditch. He seems to have been almost a lone laborer at this undertaking from about 1815 until about 1831.

Skipwith employed the method outlined below. Using the rafter level ditches, 3 feet wide and 2 feet deep were conducted from the center of the hillside field to ravines on either side. These ditches were dug with the spade and the dirt placed on the embankment on the lower side of the ditch. The ditches were placed 20, 50, or 100 yards apart, according to the steepness of the slope. In plowing and cultivating, the furrows were made parallel with the ditches if the hill was very steep but were made on a contour if the declivity was not so great.

James C. Bruce, of Halifax County, began hillside ditching in 1830 and laid claim to an improvement on Skipwith's method. His hillside furrows were made with the plow and hoes. Three rows were plowed on the lower side of the line run by the rafter level, throwing the dirt uphill. Four rows were then plowed on the upper side, throwing the dirt downhill. The hoes then drew the dirt of the four rows onto that of the three and an embankment was completed with a trench on its upper side 3 feet wide at the bottom. Bruce gave his hillside furrows a fall of about three-fourths of an inch in 12 feet and placed each furrow some 30 yards from the next. If a ravine in which to empty the water was not near at hand, he thought it well to dig a spade ditch 3 feet wide and 2 deep directly down the slope to receive the water of all the furrows (*23*). Some writers suggested that this device was not desirable, but that the hillside furrow should be conducted to the nearest branch or ravine, even though it were half a mile away (*64*).

There was some difference of opinion as to which of these two methods, Skipwith's or Bruce's, was the better. The hillside ditch was objectionable on several grounds: (1) It was more difficult to construct than the furrow; (2) it offered obstructions to the carts carrying off the crops; and (3) the sharp embankment could not be cultivated but must be left to briers and weeds. The hillside furrow seemed designed to meet these objections and ultimately gained in popularity over the Skipwith method (*4: 65, p. 681*).

The rafter level continued to be the most popular instrument for grading ditches. For this purpose it was gaged beforehand by placing it on some level floor, slipping blocks of 1-, 2-, or 3-inch thickness under one of the legs, and marking the position of the plumb line on the crossbar. The proper fall could be given the ditches by using these marks. By tacking a block of the desired thickness to the bottom of one of the legs and by keeping the plumb line on the center mark a uniform grade could also be maintained (*79*). There were other less popular leveling instruments in use. One, described as especially adapted to gently undulating land, was made by securing two pieces of board of the same length at right angles to each other and placing these horizontally on a strong staff. This staff was to be driven into the ground. It had a mortise in its center in which a plumb bob was hung. A modification of this instrument to secure it against warping was a box with diagonal braces in which the plumb line was suspended, the whole supported by a tripod (*67*). There was at least one water level on the market. It was a **U**-shaped tin tube 3½ feet long, having two upright glass vials at either end, fixed on a staff. An unbroken column of colored liquid filling the tube and coming up into the vials was the medium whereby the horizontal position was determined. This instrument sold in Richmond for $1.25. These leveling devices were to be used with the aid of a rod in the same way as modern levels (*45*).

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[11] William Massie to N F. Cabell, Pharsalia, Nelson County, Feb. 8, 1854, Cabell mss., Va. State Library, Richmond.

As the practice of hillside ditching spread it became evident that no rigid rules as to the size of the ditches, their distance apart, or the proper fall, could be given for all situations. Each one of these three factors was of vital importance if the system of ditching was to be a success, and each aroused much discussion in the agricultural press. There was general agreement that ditches should be as short and straight as possible. The grade of three-fourths of an inch in 12 feet used by Bruce in Halifax County seems to have been considered too little by farmers in other parts of the Piedmont, but on the more gentle slopes of the Tidewater even less of a grade was required. DuVal (*34*) of King and Queen County, finding that a 2- or 3-inch fall for ditches spaced at intervals of 30 yards was satisfactory, could not understand why Thomas B. Gay, of Goochland County, should find it expedient to give a fall of 3 inches in 12 feet in ditches spaced at intervals of 40 or 50 feet. Gay (*40*) explained that he lightened the burden required of the ditches not only by placing them as close together as this but also by plowing his land into 12-foot beds. The water was divided by these beds and was conducted from each into the trenches without causing gullies. Although Gay recognized that the fall in the ditches should vary with the slope of the land, he considered that the amount of the incline was not as important as providing a fall throughout the entire length of the ditch.

In Nelson and Amherst Counties a grade of 1 inch in 10 feet was recommended for hillside furrows spaced from 40 to 60 yards apart. From Waterloo, N. C., came the advice to give a much greater fall to the ditches or furrows than was the common practice. If they showed a disposition to wash too deeply, stones, blocks of wood, or similar trash could be thrown into them at intervals of about 100 yards (*44*). After the practice of hillside ditching had been in vogue some 30 years, one farmer pointed out that for long ditches the fall should increase toward the lower end so that the greater volume of water collecting there could be carried off readily. The bottom of the ditch would then scour enough to prevent the ditch from silting up (*79*).

An overseer on a plantation in the lower South wrote on this problem in the year before the Civil War. He believed that in order to be preserved a hillside furrow should be increased in size by one plow furrow for every 100 yards in length. Thus, for the first 100 yards it should be four plow furrows wide, for the second hundred, five furrows, and so on. In spacing the hillside furrows consideration should be taken of the surplus water. At the point below the first hillside furrow where this surplus water started to carry off the soil, another furrow should be placed. There should be 9 inches fall in the first 36 feet and 1½ inches per 12 feet thereafter if the ditch was to be not over 200 yards long. If it were necessary to make it longer the fall for the first 100 yards should be 1 inch per 12 feet and for the second 100 yards, one-half inch (*93*). Another farmer of the deep South pointed out that the grade of the ditches should also depend upon the character of the soil. If there was a firm clay foundation the ditch could have more fall without danger of causing a gully, but for coarse, sandy land the fall should be less (*15*).

Certain interesting adaptations to local or special conditions were made. For instance, one Halifax County farmer found that mole holes in his embankments caused the water to seep through and form gullies. He avoided this by making his embankment of the clay subsoil (*47*). In order to prevent accumulations of water from breaking over from an upper ditch and destroying the one below, a Charlotte County farmer ran small water furrows at a gently sloping angle from the bank of the upper into the lower ditch.

The common practice in providing outlets for the hillside ditches or furrows was to discharge them into the nearest convenient depression, fence row, or road cut. Some farmers advocated digging a special ditch for this purpose. The overseer of the deep South, quoted above, recommended this very strongly. He would have these conductors made with a spade and large enough to hold the water of all the tributary hillside furrows. It was important, he said, that the furrows should not be emptied under the fence into the road, since by this means a "hog hole" would soon be formed and the road ruined. Unless some precaution was taken with the outlet the process of gullying might be accelerated rather than prevented by hillside ditches. For this reason the early Virginia exponents of ditching often sowed redtop in the hillside ravines used for outlets. This served the double purpose of preventing gullying and securing a hay crop from an otherwise unproductive strip of land (*4*). One farmer who had a gently rolling piece of land affording few convenient outlets for ditches believed that a rock-paved ditch running straight down the declivity would serve the purpose. If a scarcity of rock made this impossible, he recommended that on land of such gentle slopes as his a perfectly level hillside ditch or furrow would be reliable (*67*).

The spaces between the hillside furrows should be cultivated with a view to preventing the accumulation of water in any one place before its discharge into the furrows. One way of accomplishing this was by making each corn and tobacco row carry off its own water into the hillside furrow (*48*). The bedding method of wheat culture used by Gay (*40*) has been noted. To prevent giving too much or too little fall to the land between the hillside furrows he plowed alternately parallel to the upper furrow and then to the lower, finishing the plowing midway between them. In order to secure accurate spacing in his plowing he attached a measuring stick at right angles to the beam of the plow with a switch to drag the ground at the outer end of the stick. This aided in maintaining the same distance from the next plow furrow.

Perhaps the most complete and scientific exposition of the engineering methods used to prevent soil erosion written before the Civil War was that of Sorsby (*82*). Although his pamphlet was not written primarily for Virginians, his conclusions are of general application. He summarized the various practices of cultivating to prevent washing. The first, he said, was the method of running crop rows horizontally. The second was the grading method, whereby crop rows were given a slight inclination downhill in order to drain the land of the excess water. Hillside furrows or ditches could be used to supplement both the horizontal or the grading method, said Sorsby. The horizontal method was much to be preferred and hillside ditches were to be used as little as possible. Variations in method should be used to suit different situations.

> The size of drains and ditches should be determined by reference to a variety of circumstances, the combined influence of which may generally be estimated in practice, although not reducible to any very exact rules, viz; 1st. we must consider the annual quantity of rain; 2d, the quantity which falls on the land during a heavy rain; 3d, the nature of the soil as to porosity or compactness; 4th, the inclination of land; 5th, the length of slopes and extent of surface to be drained. Every horizontaler must take into consideration these things, and judge for himself.

He gave the following table (table 1) of recommendations for the construction of soil-saving structures:

TABLE 1.—*Sorsby's table on soil-saving structures*

Character of soils	Drains					
Not subsoiled	Depth of soils		Depth of drains		Kind of drains	Distance apart
POROUS	*Feet*	*Inches*	*Feet*	*Inches*		*According to the Declivity of Land*
Light loam (fresh land)	1	00	0	10	Guard-Drains	Wide apart
Sandy " " "						
Light gravelly sand	0	10	1	00	Guard-Drains	Wide apart
Coarse gravelly sand						
MEDIUM						
Clayey loam	0	8	1	00	Guard-Drains	Not so wide apart
Gravelly loam	0	10	0	10	Guard-Drains	Not so wide apart
Friable loam						
COMPACT						
Tenacious clay	0	6	1	00	Hill-Side ditches	Need Subsoiling Close together
Friable clay	0	8	1	00	" " "	" "
Soft Free Clay	0	10	1	00	" " "	Not so close

By "depth of soil" Sorsby evidently meant the depth of plowed soil. It will be noted that for soils of coarser texture he recommended that the bottoms of the drains should not extend as deep as this plowed soil, while for the finer soils they should be lower than the plowing. These recommendations were for land on which the substratum plow was not used, as is denoted by the phrase "not subsoiled." By "guard drain" Sorsby meant a small hillside furrow, since, according to his definition a hillside ditch had a greater water capacity.

With most farmers approaching the erosion-control problem by the trial and error method there was bound to be considerable dissatisfaction with the various techniques. In the vicinity of Wardsfork, Charlotte County, hillside ditching seems to have been tried and found wanting. To prove its ineffectiveness dams were built across the bottoms serving as outlets on a well-ditched field. It was found by the farmer (*72*) who did this that great quantities of his own runaway soil as well as that of his neighbor's were caught by these traps, hillside ditches to the contrary notwithstanding. The conclusion was drawn that hillside ditching and horizontal cultivation were so contrary to nature that she showed her disapproval by "sending destroying rain storms." The hillside ditches could not withstand these torrents, and the "ropes of sand had snapped in ten thousand places." A sojourn in this part of the State in 1836 convinced Edmund Ruffin that the trouble lay more in the manner of constructing and caring for the ditches and furrows than in the system itself. He found that the grade lines were often carelessly and incorrectly marked off, and that none of the ditches seemed large enough to accommodate the heavier rains. Furthermore, land in clover fallow resisted washing so well that agriculturists were tempted to dispense with a system requiring much trouble and more skill than most overseers were willing to exercise.

A perusal of volumes 4 and 5 of the Farmers' Register, for the years 1837 and 1838, discloses that there was much dissatisfaction with the ditching system. There were repeated warnings that great care must be used in the construction of the furrows, warnings that were heeded or unheeded according to the inclination of the individual planter. In general, ditches or furrows, being either too small or too long or having too little fall, or combining all three faults, overflowed and broke during heavy rains. If given too little fall, they would clog with sand and rubbish and, unless cleared out, were utterly useless. Even those farmers who were most conscientious in their work often found that ditches did more harm than good.

Hillside ditching appears to have been talked about much in Virginia in the 1830's but never very extensively practiced. What vogue it did enjoy seems to have died down somewhat by about 1852. In that year a young farmer (*38*) sought information on the subject through the correspondence column of the Southern Planter. Two persons whose advice he asked orally had opposed hillside ditches; one had been in favor of them, and others had "uttered mere empty incoherences." The editor replied that although he lived in the midst of mountains, he had seen very few hillside ditches and no good ones. He confessed to a preference for deep plowing as a substitute. About the same time the owner of a James River Piedmont plantation wrote of hillside furrowing as if it had been the practice of the previous generation. He said that he had filled up many of these furrows made originally by his father but later washed into gullies. Under deep plowing the same lands showed no disposition to erode.[12] On the other hand, it seems that hillside ditching was fairly popular in the Cotton States in the decade before the Civil War. Most of the communications on the subject to the Southern Planter in that period were from the deep South.

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[12] Peyton Harrison to William B. Harrison, Clifton, Dec. 30, 1853, Cabell mss., Virginia State Library, Richmond.

Even if hillside ditches and furrows were not generally used, there were certain individuals in Virginia laboring to improve the system. Richard N. Venable, of Prince Edward County, made hillside furrows very nearly on the modern design. In order to eliminate the small ditch with its unproductive bank he made a rounded bed 10 or 12 feet wide with a water furrow of corresponding size on the upper side. This bed was to be tilled with the rest of the field and was to remain in the same place year after year. In other respects it was like the hillside ditch. The size of this structure gave it a greater water capacity than a ditch and its shape made it less likely to break when full (*89, p. 753*).

Among the first men to use the word terrace to describe this type of hillside bed was John H. Cocke, of the Bremo estates, Fluvanna County. In 1840 Cocke's overseer, evidently not a very literate person, kept a journal of work performed on the plantation. In it the building of "Terris's", "Terryss", or "Terresses" is referred to. These terraces were beds raised some 4 to 6 inches above the level of the waterway. The waterway itself was about 3 or 4 feet wide. On gentle slopes Cocke threw the dirt out of the waterway to either side, but on the steeper slopes the terrace was made on the lower side. A fall of 2½ inches for every 16½ feet was given these terraces. Cocke also claimed to have developed a horizontal terrace as a means of irrigating hillsides.[13]

CONCLUSIONS

The problem of erosion on agricultural land is not new, nor are the means of controlling it new. All of the methods in use today with the possible exception of strip cropping were known to the Virginia farmers of the early part of the last century. They used legumes and grasses to restore fertility and to bind the soil. They increased the capacity of the soil to absorb water by turning these green crops under and by deep plowing. They developed horizontal or contour plowing to conserve moisture and to prevent washing. They cultivated the land "flat" rather than in ridges to prevent the accumulation of water. They introduced the system now known as terracing to make the most effective use of the excess water of heavy summer rains. Even the suggestion of strip cropping is contained in the practice of some farmers of leaving strips of sod unplowed between the corn rows or alternating rows of corn with rows of some other crop. While some farmers, finding one particular method successful, urged it as a panacea for all erosion ills, it was generally recognized that the method must vary with different types of soil and different slopes.

With these means at hand, with other improved general farm practices, and with improved farm equipment, it was possible for the Virginian of the 1850's to conserve his soil much more successfully than did his predecessors. Nevertheless, many did not avail themselves of the new practices, and soil conservation still seems to have been the exception rather than the rule. In 1856 a writer could still complain that Virginia was "bleeding from a thousand wounds inflected by improvident husbandry", and that "we behold everywhere around us stunted vegetation, scanty crops, poverty of soil, and innumerable gullies and galds" (*46*). Another author (*42*), after quoting the passage from Taylor given above (p. 5) declared that—

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[13] Journal of General Cocke's overseer, January–April 1840; J. H. Cocke to Edmund Ruffin, Bremo, July 1854; COCKE, J. H., SR. AN ESSAY ON AGRICULTURE. Bremo Bluff, Fluvanna Co., Va. n. d.

> Nothing has yet been done to wipe from our agriculture the reproach of Arator. The alluvial treasure, annually washed from our forests and badly cultivated soils, and floated down our rivers, continues to serve no other purpose but to obstruct our navigation and poison our atmosphere. Not one scientific effort has been made to arrest it, in its progress to tidewater, and none to appropriate it below.

Although great progress had been made in the developing of soil-conservation practices during the first half of the nineteenth century, the perfecting of these techniques remained for future generations. The individual efforts of a few, no matter how intelligent these might be, could not solve the widespread erosion problem. The problem required not only accuracy and eternal vigilance in the application of erosion-control techniques but also a Nation-wide, coordinated program for preventing soil wastage.

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